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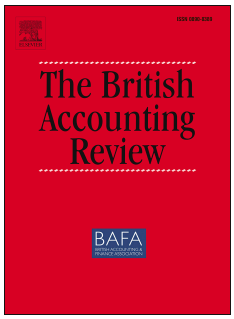

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Governance, efficiency and risk taking in Chinese banking

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ABSTRACT

We employ a hand-collected unique dataset on banks operating in China between 2003 and 2011 to investigate the impact of board governance features (size, composition and functioning) on bank efficiency and risk taking. Our evidence suggests that board characteristics tend to have a greater influence on banks' profit and cost efficiency than on loan quality. We find that the proportion of female directors on the board appears not only to be linked to higher profit and cost efficiency but also to lower traditional banking risk. Similarly, board independence is associated with higher profit efficiency of banks; while the opposite is found for executive directors and in the presence of dual leadership of the CEO/chairperson. Among the control variables, we found that liquidity negatively affects profit and cost efficiency, while positively affecting risk. Interestingly, we find some evidence of an incremental effect of specific board characteristics on efficiency for banks with more concentrated ownership structures and state-owned institutions; while for banks with CEO performance-related pay schemes the effect on efficiency when significant is usually negative. Our results offer useful insights to policy makers in China charged with the task of improving the governance mechanisms in banking institutions.

Keywords: Board governance; Bank efficiency; Asset quality; Bank ownership; Performance-related compensation; Chinese banking sector.

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1. Introduction

China's financial sector experienced rapid growth during the past three decades and has gradually transformed its largely planned economy to a more market-oriented system. The intense deregulation and restructuring process that started in the second half of the 1990s and the World Trade Organization (WTO) entry in 2001 have resulted in radical reforms and greater openness to the outside world. The banking sector in China has long been controlled by the four major state-owned banks and over recent years it has been revived by government capital injections, privatisations and foreign ownership (e.g. Garcia-Herrero, Gavilá, & Santabarbara, 2006; Berger, Hasan, & Zhou, 2009). In 2014, four out of the ten largest banks in the world by market capitalisation were Chinese, of which three are currently in the list of Globally Systemically Important Banks (GSIBs) that, since 2011, is compiled and updated each year by the Financial Stability Board (FSB, 2014).

Notwithstanding the country's fast growing economy and financial market developments (Shanghai and ShenZhen stock exchanges combined today represent the world's second-largest exchange), the Chinese banking sector is still the most important financing channel for the local economy. However, a number of studies have highlighted the legacy and persistence of China's weak legal environment and institutions, particularly in terms of investor protection systems, corporate governance, accounting standards and quality of government (Allen, Qian, & Qian, 2008).

The benefits of healthy governance frameworks are well known (Claessen & Yurtoglu, 2013) and include better performance and efficiency, greater access to financing, lower cost of capital, and a more favourable treatment of all stakeholders. Equally, poor corporate governance can increase risks by affecting the quality of bank assets and causing financial volatility, and are often associated with lack of transparency. The failure and distress conditions of many banking firms post-global financial crisis have reignited the debate over

the governance frameworks of these institutions and their impact on performance and risk-taking activities (Kirkpatrick, 2009; Mulbert, 2010; Adams & Mehran, 2012). As a result, the international regulatory bodies have issued new principles for enhancing sound corporate governance within the banking sector at a global level (Basel Committee on Banking Supervision, 2010). In China, specifically, one of the most recent objectives of the authorities' reforms was the establishment of a board of directors' system aimed at improving banks' corporate governance structures by setting standards for the composition, structure and responsibilities of the board members (see Section 2 for more details).

This paper examines the impact of board governance characteristics on both profit and cost efficiency for the Chinese banking sector over 2003-2011 and extends the investigation to the banks' risk-taking behaviour. The contributions of this study are threefold. Firstly, the literature on bank corporate governance in emerging markets is typically limited and existing studies largely focus on non-financial firms (Claessens & Yurtoglu, 2013). This is because corporate governance in banks differs in many respects from that in other firms not least because of their (the banks') business complexity, transparency, regulation and multitude of stakeholders (Mehran, Alan, & Joel, 2011). Researchers have recently turned their attention to these themes both in the developed and developing worlds (e.g. Laeven & Levin, 2009; Barry, Lepetit, & Tarazi, 2011; Pathan & Faff, 2013; Berger, Imbierowicz, & Rauch, 2014; Berger, Kick, & Schaeck, 2014). However, data availability is usually limited, particularly in emerging markets, and this largely explains the scarcity of studies. In addition, while a number of studies have investigated the board structure-performance relationship in banking using traditional accounting indicators (e.g. de Andres & Vallelado, 2008 and Pathan & Faff, 2013; and, for the Chinese banking sector, Liang, Xu, & Jiraporn, 2013), only a few have

examined it within a stochastic frontier framework that allows the estimation of profit- and cost-efficiency levels.[1]

Secondly, in this research, we hand-collected a unique dataset concerning board structures (size, composition and functioning), ownership features and CEO pay for a sample of banks operating in China between 2003 and 2011. Most previous studies on the Chinese banking sector focus on analysing the impact of ownership structure on banks' performance, and our unique data enable us to fill up the research gap by examining the impact of board characteristics. Efficiency is estimated using parametric stochastic frontier methodology both on the profit and cost sides; while risk is measured as the ratio of non-performing loans (NPLs) over total loans. Compared with previous Chinese banking studies, we use a much larger unique sample for our analysis and employ the two-step system dynamic Generalised Method of Moment (GMM) approach with Windmeijer-corrected standard errors to control for potential endogeneity, which enhance the quality of the research findings. In addition, we test the robustness of our results by using alternative definitions of banks' inputs and outputs for the estimation of the best-practice frontiers.

Our evidence suggests that board characteristics tend to influence banks' profit and cost efficiency more than loan quality does. We find that the proportion of female directors on the board appears not only to be linked to greater profit and cost efficiency but also to lower

[1] The classical approach to the evaluation of bank performance concentrates on financial ratios such as return on assets and cost/income ratio. However, these fail to capture the multidimensional character of banks' production process and to control for the differences in input/output prices and other exogenous market factors. In recent years, academic research has increasingly focused on frontier analysis to measure the performance of banks and other financial institutions. Many studies (e.g. Fried, Lovell, & Schmidt, 1993; Bauer, Berger, Ferrier, & Humphrey, 1998; Cummins & Weiss, 2000) have argued that frontier efficiency measures yield more accurate estimates of the underlying performance of financial firms.

traditional banking risk. Similarly, board independence is associated with banks' higher profit efficiency while the opposite is found for executive directors and in the presence of dual leadership of the CEO/chairperson. Among the control variables, state-owned banks show higher cost efficiency than non-state owned banks. The bank liquidity ratio is the most significant in reducing profit and cost efficiency and increasing risk. This is an important finding as prudential regulators are increasingly focusing on banks' liquidity requirements in the aftermath of the global crisis.

The third contribution of this paper lies in providing an empirical investigation of the incremental effect of board governance features on banks' efficiency levels and traditional banking risk under different conditions, namely i) the level of ownership concentration; ii) state vs private ownership; and iii) the presence of CEO performance-related compensation schemes. We find that the incremental effects of board governance structures for banks characterised by concentrated ownership, when significant, are usually positive (as in the case of executive and independent directors), whereas results for risk are always insignificant. Our evidence further shows that the same two specific board composition variables have also a positive incremental impact on bank efficiency in the case of state owned institutions. Interestingly, for banks with CEO performance-related pay the effect on efficiency when significant is usually negative.

Our findings are consistent with alternative efficiency measures and provide important policy insights regarding bank governance in emerging markets where minority investor protection is particularly weak. In particular, they suggest that a sound corporate governance system is critical for Chinese banks to maximise their profits. The knowledge and understanding obtained in this study under the current banks' governance structure can shed light on the potential direction for future governance reforms in Chinese banking.

The paper proceeds as follows. In Section 2 we provide an overview of the key recent reforms in Chinese banking. In Section 3 we review the relevant literature and formulate the main hypotheses. Section 4 provides a detailed description of the sample, data and methodological approach. Section 5 discusses the empirical findings, and Section 6 concludes.

2. Key reforms in the Chinese banking sector

Since the late 1970s, the Chinese government has implemented gradual but far-reaching reforms to address the institutional, organisational and political problems faced by its banking sector. One was the change from the mono-banking system into a plural-banking system consisting of a central bank and a variety of banking institutions; the other was the transition from a specialised to a commercial banking system (Min, Jinqing & Avery, 2009). The reform process can be broadly divided into three distinct time periods (e.g. Berger et al., 2009; Fu & Heffernan, 2009). From 1978 to the early 1990s, four large state-owned banks were re-established or separated from the country's central bank (People's Bank of China, PBOC) from which they took over the commercial banking business. In the mid-80s, several new joint stock commercial banks (JSCBs) also entered the market.

The second wave of reforms occurred in the 1990s up until the entry of China to the WTO and was focused on encouraging state-owned banks to implement market-oriented practices. Three policy banks were created to separate policy-directed lending from the Big Four[2]; 112 City Commercial Banks (CCBs) were also established by city governments

[2] The "Big Four" are the Agricultural Bank of China (ABC), Bank of China (BOC), China Construction Bank (CCB) and Industrial and Commercial Bank of China (ICBC) and they are often referred to as State-owned Commercial Banks (SOCB). The three policy banks created in 1994 are the Agricultural Development Bank of China (ADBC), China Development Bank (CDB), and the Export-Import Bank of China (Chexim).

through the restructuring and active merging of over 5000 urban cooperative banks. In addition, the Central Bank Law and the Commercial Banking Law were enacted to enhance the independence of the central bank and commercial banks; the government injected capital and reduced non-performing loans in an attempt to repair the balance sheets of the state-owned banks. Furthermore, foreign banks were allowed to carry out basic functions in China, although there were many restrictions in place until after the country joined the WTO in 2001.

The third period includes the early 2000s up until the most current years when speed of reforms accelerated with the aim of enhancing the reputation and the international competiveness of the Chinese banking sector. In March 2003 the government transferred the central bank's supervisory and regulatory functions to the China Banking Regulatory Commission (CBRC). Since its inception, the CBRC has focused on critical areas such as accounting requirements and standards for loan classifications, capital adequacy, risk management and internal controls, and corporate governance.

2.1 Recent progress in the Chinese bank governance frameworks: a bird's eye view

The CBRC has been particularly active in relation to the policy framework for bank corporate governance and over the past ten years it promulgated several important guidelines.[3] Among the key aims were to enhance internal management and controls and

[3] Specifically, in 2005, the CBRC promulgated the "Guidelines for Board of Directors Code of Conduct of Joint Stock Commercial Banks" and in 2006 the "Guidelines to Corporate Governance of State-owned Commercial Banks and the Relevant Supervision"; and the "Guidelines on Internal Audit of Banking Institutions". These guidelines, as stated in the CBRC website, function as *both an elaboration of and a supplement* to the "Guidance on the Corporate Governance of Joint Stock Commercial Banks" and "Guidance on Independent Directors and External Supervisors of Joint Stock Commercial Banks" issued by the People's Bank of China in 2002.

standardise banks' board structures with the intention to create boards as 'strong' and functional as those in developed countries (Liang et al., 2013). As a result, Chinese banks have made great progress in the establishment of a board system, gradually introducing an independent director system and a specialised committee system and laying the foundations for the board's independence and effective operations. Nowadays, almost all Chinese banks have followed the guidelines and have adopted a four-tier governance system that includes shareholders' general meeting, board of directors, board of supervisors, and senior management where the shareholder meeting has the ultimate power to select directors and supervisors. The board of directors in Chinese banks is typically composed of the executive directors, the full-time non-executive directors, and the part-time independent directors (Cossin & Lu, 2013). In addition, banks were required by the CBRC to establish several special committees, including a strategic development committee, an audit committee, a risk management committee, a personnel and remuneration committee, and a connected transition control committee, all under the board of directors.

Table 1 presents selected examples of the board composition for different types of Chinese banks. The supervisory board is established alongside that of directors to exercise checks on the management team and board of directors.[4] Under the leadership of the board of directors, the senior management team executes strategy and is responsible for its daily operation and management activities.

<Insert Table 1 around here>

[4] Unlike German banks, the supervisory board in Chinese banks does not take major business decisions, but serves as a monitoring organ (Xiao, Dahya, & Lin, 2004).

The latest CBRC regulations (2013) "Guidelines on Corporate Governance of Commercial Banks" (referred to in official documents as *The Guidelines*) were promulgated to address existing problems in the corporate governance of the banking institutions and with reference to the experiences of international regulatory reforms since the global financial crisis of 2007-08.[5]

Over the past decade, the Chinese authorities also implemented another important strategy to improve banks' corporate governance, with the aim of encouraging banks to adopt a more diversified shareholding ownership structure. Under this strategy, two main approaches were initially pursued in exchange for more effective monitoring. The first was to sell strategic stakes to foreign investors. Introducing foreign strategic investment leads to a more diversified ownership structure, which in turn increases the pressure on banks to improve their internal governance system (Hasan & Xie, 2013). Meanwhile, it has been observed (Berger et al., 2009) that the foreign strategic investment also allows the investors to directly participate in banks' management by occupying one or two seats on the management board and this direct involvement can enhance information transparency and strengthen bank management.

The second approach was to encourage banks to become listed on Chinese and foreign exchanges through initial public offering (IPOs). For example, by the end of 2014, there were 21 Chinese banks listed on domestic stock exchanges and/or the Hong Kong Stock Exchange. Among them, 14 Chinese banks launched IPOs during our sample period, 2003-2011. Two of the most favourable effects of bank IPOs were the improvement of information disclosure and allowing market forces to act as an effective discipline mechanism on bank performance.

[5] The document summarises the practices and experiences in the supervision of Chinese banking institutions and maps out the future direction for the development of sound corporate governance for banks operating in China.

3. Conceptual framework and empirical hypotheses

Over the past decade, banks' corporate governance has received increasing academic interest both in the developed and emerging worlds (see, for example, the recent surveys by de Haan & Vlahu, 2013; and Hagendorff, 2014). However, only a handful of recent studies examine the relationship between governance, bank efficiency and risk taking and these typically focus on the US and European banking sectors. Indeed a few studies have examined the impact of alternative bank board characteristics on either different measures of accounting performance (de Andres & Vallelado 2008; Adams & Mehran, 2012; Pathan & Faff, 2013); operating efficiency (Jiang, Yao, & Zhang, 2009; Agoraki, Delis, & Staikouras, 2010; Tanna, Pasiouras, & Nnadi, 2011); or risk (Pathan, 2009; Berger et al., 2014b). Overall, evidence suggests that effective and efficient governance is more likely to occur in small, independent and well-diversified boards, albeit such "strong" boards may not be optimal for banking firms if they translate to a greater risk propensity.

A strengthened board structure should mitigate the agency problems and align the interests between shareholders and managers as well as help enhance the monitoring effect over the CEO's and managers' decision making. This would include decisions regarding banks' operations such as the selection of inputs and outputs, which directly influence banks' efficiency levels and are also related to risk taking. It would therefore be reasonable to assume that enhanced board structures and decision-making processes will positively affect the quality of bank management and banks' frontier efficiency scores, which derive from sophisticated techniques to assess performance (e.g. Bauer et al., 1998).

In this short review, we first examine a set of board characteristics (size, composition and functioning) that are deemed to significantly impact on bank efficiency and risk taking.

Then we concentrate on studies focusing on the importance of ownership structures and pay-for-performance incentive schemes for bank efficiency and risk.

3.1 Board governance: size, composition and functioning

3.1.1 Board size

In relation to board size, the standard argument (Jensen, 1993; Hermalin & Weisbach, 2003) is that the larger the board, the less effective it is at monitoring management. This is because of greater agency costs, particularly in terms of free-riding problems among directors, coordination and communication difficulties, and greater and longer decision-making time. The empirical evidence, though, is mixed (Adams & Mehran, 2003, 2008, 2012; Aebi, Sabato, & Markus, 2012). Several studies observe that larger boards may be needed in large financial institutions to reflect the complexities of their business models, to increase the pool of expertise and resources available, and to increase the potential of establishing contacts with diverse customers and depositors (Dalton, Daily, Johnson, & Ellstrand, 1999).[6] In a comprehensive review of UK banks' corporate governance, Walker (2009) notes that banks should aim for an 'ideal' size of 10-12 members; while Ladipo & Nestor (2012) indicate that the best performing European banks have *smaller and more 'mature'* boards. Also Pathan & Fuff (2013) reveal that US banks with a small board have superior financial performance.

In light of these considerations, we adopt a view similar to that of Grove, Patelli, Victoravich, and Xu (2011), which contends that banks can benefit from large boards in terms of performance up to a certain point. Thereafter the relationship becomes negative due

[6] One case in point is bank holding companies (US's BHCs) that comprise a number of subsidiaries that have their own boards of directors. To facilitate coordination and monitoring, these subsidiaries should be represented on the holding companies' boards.

to the lack of efficient monitoring by the board, organisational difficulties, and greater agency problems.[7] Based on this, our first hypothesis is:

Hypothesis 1. (H_1): The relationship between board size, bank efficiency and loan quality is concave (inverted U-shaped).

3.1.2 Board composition (female, foreign, executive, and independent)

In addition to size, board diversity has often been associated with better firm performance, quality of earnings and/or lower risk-taking propensity. As we will see in this section, the existing empirical evidence is mixed, but banking authorities and policy makers globally are actively implementing policies to encourage banks to promote heterogeneity in the boardroom. This study tests the general hypothesis that boards characterised by more diverse and more independent directors are better at monitoring bank managers, thereby resulting in more efficient and less risky banking institutions, as follows:

Hypothesis 2 (H_2): The presence of more diverse and independent boards is positively related to bank and loan quality.

If greater diversity in the composition of the board is expected to enhance bank efficiency and loan quality, it is also plausible to expect that the potential combined effect of having more diversity (i.e. a greater proportion of female, foreign, executive and/or

[7] Standard accounting-based measures of performance similar to those used in Grove et al. (2011) do not consider input prices and output mix and ignore the market value of the bank. However, cost and profit efficiency scores can help enhance the performance evaluation of the banks. Therefore, in this context, we assume the same reasoning applied to performance be valid in the case of profit and cost efficiency.

independent directors) is driven by single components of the board. Therefore, we also formulate four separate hypotheses (H_2a-H_2d), one for each of these factors. The first is gender diversity.

A higher proportion of females on boards has often been found to affect governance dynamics in several meaningful ways. Nonetheless, the evidence on the impact on firm performance and risk is far from straightforward. Kanter (1977) suggests that performance advantages will result only when the proportion of women in the boardroom achieves the sort of 'critical mass' that will allow them to 'form coalitions, support one another and affect the culture of the group'. Other studies found a positive relationship between a higher proportion of female directors and accounting performance (Carter, Simkins, & Simpson, 2003; Erhardt, Shrader, & Werbel, 2003; Catalyst, 2004). In a study on gender diversity in an Asian context, Kang, Ding, and Charoenwong (2010) find that investors' reactions to women appointed as directors in publicly listed firms in Singapore is positive. Yet, recent research has revealed that a greater proportion of female directors negatively influences firm value either because of excess monitoring (Adams & Ferreira, 2007) or due to lack of experience, as in the natural experiment conducted by Ahern and Dittmar (2012) on Norwegian firms. Concerning gender differences in risk attitude, research in organisational psychology and economics well documents that, on average, women naturally tend to be more risk-averse than men. The related literature for the specific banking sector is very limited. Interestingly, a recent study by Berger et al. (2014b) finds that in the three years following the increase in female board representation, risk taking increases for banks in Germany, although the economic impact is marginal. Given the above, our hypothesis is formulated as follows:

Hypothesis 2a (H_2a): The presence of more female directors on the boards positively affects bank efficiency and loan quality.

There are also potential benefits of including foreign directors on a board. Masulis et al. (2012) argue that the advisory ability of the board can be enhanced through their extensive experience and knowledge of foreign markets and their networking connections. However, the presence of foreign directors may also weaken the effectiveness of monitoring due to the substantial oversight costs of on-site visits and attending meetings that they incur. Foreign directors may not be familiar with the local systems that makes it difficult for them to play a monitoring role as a component of the corporate governance mechanism. This could be due to either lack of knowledge of local markets or barriers posed by language, culture and regulations. Consistent with Adams et al.'s (2010) survey, Masulis, Wang, and Xie (2012) show that foreign directors have a lower attendance rate at board meetings, and firms with foreign directors tend to have a lower return on assets. In contrast, Berger et al. (2009) and Liang et al. (2013) maintain that foreign directors on the boards of Chinese banks can potentially contribute to better performance by bringing new technology and managerial techniques and skills. We endorse this view and express hypothesis 2b as:

Hypothesis 2b (H_2b): The presence of more foreign directors on the boards positively affects bank efficiency and loan quality.

De Andres & Vallelado (2008) observe that efficient boards should also have a good proportion of executive directors. This is because they facilitate the transfer of information between board directors and management and have specific knowledge of the banking institution that could effectively complement the abilities of the non-executive directors. The main concern is that the monitoring of top managers may be weakened when executives also act as directors and this, in turn, may result in higher internal governance costs. Nevertheless,

the empirical evidence is generally ambiguous. Executive directors on a board may be of benefit to the implementation of a firm's business operations and strategies due to their greater knowledge or experience, which by implication can improve firms' efficiency or performance (Baysinger & Hoskisson, 1990; Bhagat & Black, 1998). Stock markets have also been found to respond positively to announcements of appointments of non-executive directors (Rosenstein & Wyatt, 1990; Cotter, Shivdasani, & Zenner, 1997) and positive effects on the firm's accounting performance have been documented by, among others, O'Connell and Cramer (2010) and Liang et al. (2013). However, Hermalin & Weisbach (1991), Dulewicz & Herbert (2004), and de Andres & Vallelado (2008) do not reach this conclusion; for example, these authors show that an optimum combination of executive and non-executive directors is a necessary condition for firm value. Nonetheless, in this study we hypothesise that:

Hypothesis 2c (H_2c): The presence of more executive directors on the boards positively affects bank efficiency and loan quality.

We also consider board independence as one of the critical features that may impact Chinese banks' efficiency and risk-taking activity. There are several theoretical motives as to why greater independence of directors may be beneficial to the effectiveness of the board; for these we can be refer back to the seminal works by Fama (1980) and Fama & Jensen (1983). One line of argument emphasises the role of the incentives that independent directors have to protect their reputation in the market for independent directorships in the banking sector. This should make them more effective at monitoring and disciplining managers, reducing opportunistic costs, and protecting shareholders' interests. Board independence is expected to have a positive effect on firm performance (Pathan, Skully, & Wickramanayake, 2007),

although empirical studies do not appear to always confirm this prediction (e.g. Agrawal & Knoeber, 1996; Skully, 2002; Hermalin & Weisbach, 2003; Park & Shin, 2004). In fact, various studies (e.g. Adam & Ferreira, 2007) have highlighted some of the drawbacks of having independent directors if, for example, their presence weakens the propensity of the CEO to share information with the board. Studies on the banking sector seem to support this latter view and provide evidence of lower performance (e.g. Minton, Taillard, & Williamson, 2011; Adams & Mehran, 2012; Aebi et al., 2012; Beltratti & Stulz, 2012; Erkens, Hung, & Matos, 2012), and lower risk taking (Pathan, 2009; Mongiardino & Christian, 2010; Minton et al., 2011; Aebi et al., 2012; Ellul & Yerramilli, 2013). The hypothesis we test in this study predicts a positive effect on both efficiency and loan quality and can be expressed as follows:

Hypothesis 2d (H_2d): The presence of more independent directors on the boards positively affects bank efficiency and loan quality.

3.1.3 Board functioning (CEO duality and frequency of meetings)

Another important characteristic of the boardroom is the dual appointment of the CEO and Chairman of the board. There are two opposing arguments in the literature on the potential effects on firms' operations and performance. On one hand, the agency theorists argue against CEO duality because it weakens the monitoring powers of the boards and it increases internal governance costs as well as risks. According to this view (e.g. Lipton & Lorsch, 1992; Jensen, 1993; Lasfer, 2006), duality enables CEOs to leverage their power for their own personal outcomes, an effect that has recently been associated by some authors (Dey, Engel, & Liu, 2011) with the 'entrenchment theory'. On the other hand, the stewardship or organisation theorists (e.g. Anderson & Anthony, 1986) contend that combined leadership structures at the corporate top can decrease information costs and

improve stability, thereby enhancing firms' performance and organisational efficiency in corporate leadership.

Empirical studies on the banking sector provide mixed findings. Focusing on US banks, Aebi et al. (2012) and Berger et al. (2014a) do not find evidence of entrenchment theory. Pi & Timme (1993), Larcker, Richardson, and Irem (2007) and Wang, Lu, and Lin (2012) show that CEO duality lowers bank performance; whereas Grove et al. (2011) and Pathan (2009) find evidence that it increases bank risks.

In our paper we test the validity of the entrenchment theory that means that we expect the concentration of leadership (the presence of a dual CEO/chairperson) to result in lower bank efficiency. This is because duality can lead to increased agency conflicts since the board's ability to monitor the CEO is reduced, which in turn infers that the CEO has increased power to influence board decisions and act in their own interests. As a result, loan quality is also expected to deteriorate as evidenced, for example, in Grove et al. (2011).

Hypothesis 3. (H_3): The presence of a dual CEO negatively impacts bank efficiency and loan quality.

Finally, we are interested in testing whether the frequency of meetings has any performance benefits in terms of efficiency and asset quality. The agency framework (Conger, Finegold, & Lawler III, 1998) suggests that there is a positive relationship between the number of board meetings and internal corporate governance and supervision, thus indirectly facilitating greater performance via reduced agency costs and lower risk taking. Adams and Mehran (2003) and Grove et al. (2011) observe that, compared to non-banking firms, banks require more frequent board meetings (in addition to larger and more active boards) because of their business complexity; however, once again, the empirical evidence

for this assertion is mixed. For example, de Andres and Vallelado (2008) do not find a significant relationship between board meetings and bank performance, although Adams and Ferreira (2007) find the opposite result. For the Chinese banking sector, Liang et al. (2013) reveal that board meeting frequency as well as board independence improve both bank performance and asset quality. Therefore, we predict a positive relationship between the number of board meetings and bank efficiency and loan quality.

Hypothesis 4. (H_4): A greater frequency of board meetings improves bank efficiency and loan quality.

3.2 Testing the effects of ownership and CEO's performance-related pay

The differential effects of board characteristics on bank efficiency and risk are also examined empirically in this study according to three criteria that are deemed particularly relevant for the Chinese banking sector: ownership concentration, state ownership, and CEO performance-related pay.

The first criterion is ownership concentration. We discussed in Section 3.13 that duality of powers can result in entrenched management. In fact, this can also occur when high ownership concentration provides an incentive for the largest shareholder to extract control benefits and expropriate the wealth of outside or minority shareholders. Most East Asian markets, including China, are characterised by relatively high ownership concentration. This feature can affect banks' internal governance, operations and performance via the entrenchment effect described in the previous section (see also Johnson, La Porta, Lopez de-Silanes, & Shleifer, 2000 and Claessens, Djankov, Fan, & Lang, 2002). It is possible that in a market with weak investor protection, large shareholders are more influential over corporate

decision-making and have more incentives to increase the level of risk taking. Evidence of this effect on the banking sector is found, for example, in Laeven & Levine (2009). In a study on China's banks, García-Herrero, Gavilá, and Santabárbara (2009) also report a negative association between ownership concentration and performance. However, concentrated ownership may also result in greater alignment with the interests of minority shareholders when controlling shareholders provide more effective internal monitoring – for example, by exercising greater control over executive compensation and management turnover. This result is confirmed e.g. in Kaplan and Minton (1994) and Hartzell and Stark (2003), among others, for the non-financial sector; and Dong, Meng, Firth, and Hou (2014) for the Chinese banking sector. In comparison with developed markets, ownership structures in emerging economies are characterised by a much higher level of ownership concentration. Indeed, several previous studies tend to support the monitoring role of large shareholders since important external market mechanisms for disciplining managers, such as disciplinary takeovers, are significantly weaker for banks (Prowse, 1997).

The second criterion is state-owned versus private ownership. In this regard, it is worth noting that in the Chinese banking sector, the literature on the impact of board governance is relatively limited. The majority of studies typically concentrate on ownership characteristics, and distinguish between state-owned versus private banks and domestic versus foreign-owned ones.[8] Fu and Heffernan (2007), Lin and Zhang (2009), Zhang, Wang, and Qu (2012), Jiang, Yao, and Feng (2013) and Dong et al. (2014) find that state-owned banks are less profitable, less efficient, and suffer from poorer asset quality compared to their private counterparts. In fact, a number of studies indicate that the prevalent high level of state ownership in Chinese listed firms weakens the corporate governance mechanism as it

[8] For example, Berger et al. (2009; 2010) provide evidence that foreign banks tend to be more efficient than (or approximately equally efficient to) private domestic banks.

explicitly promotes the entrenchment effect (Shleifer & Vishny, 1997; Morck, Yeung, & Yu, 2000; Gul, Srinidhi, & Ng, 2011). This latter provides an incentive for the entrenched state shareholder to extract control benefits and expropriate the wealth of outside or minority shareholders. For the state-owned firms, the pursuit of political objectives increases conflicts of interest and inevitably affects operating performance and efficiency, as documented in various studies on the Chinese banking sector - for example, those by Chen, Firth, and Xu (2009), Berger et al. (2009) and Jiang et al. (2013). Furthermore, various authors have highlighted the importance for Chinese state-owned firms of alternative effects on performance via accrual and real earnings management (Kuo, Ning, & Song, 2014). In this case, the manipulated performance is the result of stronger entrenchment effects (Yuan, Zhang, & Zhang, 2007) and/or collusion with small audit firms (Wang, Wong, & Xia, 2008). Hence, we expect that, in state-controlled Chinese banks, board characteristics will have no significant effects on efficiency, while could result in greater risk-taking activity mainly driven by lax risk management and excess lending.

Finally, the CEO compensation structure is another important mechanism to deal with governance problems (Brickley & James, 1987; Crespí, Garcia-Cestona, & Salas, 2004; Caprio, Laeven, & Levine, 2007) and is our third chosen criterion. Compensation can reward or incentivise performance; but can also indirectly increase risk propensity. In theory, CEO compensations should be structured in such a way as to increase the alignment effect and act as an important incentive for top executives to enhance their mutual monitoring activities. Indeed, several recent studies focusing on the banking sector have shown that CEO compensation is positively associated with performance (for example, Ang, Lauterbach, & Schreiber, 2001 and Livne, Markarian, & Mironov, 2013). That is, the implementation of CEO pay-for-performance schemes can mitigate agency problems and enhance internal corporate governance (Hall & Murphy, 2002; Core, Guay, & Larcker, 2003) and thus the

effects of board characteristics can be less significant than in the case of those firms without such schemes. However, other recent studies have also warned of the positive association of these schemes with risk-taking activities (Chaigneau, 2013; Ravia & Sisli-Ciamarra, 2013).

4. Methodology and data

4.1 The model

In this paper, we examine the impact of board characteristics on the efficiency and risk-taking activities of Chinese banks. We use the two-step system dynamic Generalised Method of Moments (GMM) approach with Windmeijer-corrected standard errors to control for potential instances of endogeneity (Blundell & Bond, 1998) and for the downward bias in the estimated asymptotic standard errors. The endogeneity problem arises because there is a possibility of reverse causality that certain board characteristics may be determined by performance (efficiency and asset quality) or that governance may be derived by underlying unobservable factors that impact performance. There are various sources of potential endogeneity in corporate finance research as extensively discussed e.g. in Wintok, Linck and Netter (2012) and often empirical studies ignore the possibility that current values of governance variables are a function of past firm performance. As shown in the model specified in equation (1), we regress the profit and cost efficiencies and a risk-taking measure (alternatively in *BER*) on a set of board characteristics and control variables, as follows:

$$BER_{it} = \alpha_0 + \alpha_1 BER_{it-1} + \sum_{j=1}^{8} \beta_j B + \sum_{k=1}^{13} \gamma_k Z + \varepsilon_{it} \quad (1)$$

where *i* identifies the cross-sectional dimension across banking firms, and *t* denotes the time dimension. ε_{it} is the random error term, and *BER* is the dependent variable, which is alternatively profit efficiency (π-eff), cost efficiency (c-eff) and traditional banking risk (NPLs). Efficiency levels are computed by estimating a stochastic translog cost function as described in Appendix B. Risk is traditional banks' risk associated with lending, and is proxied by the level of non-performing loans (NPLs) to total loans[9]. In order to apply the dynamic Generalised Method of Moments (GMM) approach, we also include one lag of dependent variable, BER_{it-1}, in the regression. When *BER* is either profit or cost efficiency our instruments for the GMM estimation are one lag of the dependent variable and the NPLs ratio. Alternatively, when *BER* is the bank risk-taking variable, we use two lags of the dependent variable (NPL ratio) as instrumental variables.

We incorporate a vector of board characteristic *B* into our analysis that reflects size, composition and functioning. In order to explore whether board size (*Bsize*) has a non-monotonic effect, we also add the squared value of the board size (*SqBsize*) in our model. For board composition, we test for the percentage of female (*Femdir*), foreign (*Fordir*), executive (*Execdir*) and independent directors (*Bindep*). The functioning of the board is explained by a dummy variable (*Duality*), which is equal to 1 if the CEO is also the chairperson or vice-chairman of the board; whereas *Bmeeting* is the number of board meetings held annually.

In line with the previous literature, we also consider a set of control variables, *Z*, that includes bank-specific and macroeconomic factors that may affect a bank's cost and/or profit efficiency level and risk-taking behaviour. Many studies have found that ownership

[9] Chinese commercial banks adopt a five-category loan classification system. Under this system, bank loans are classified as performing loans (normal and special mention) and non-performing loans (sub-standard, doubtful and loss loans) based on their inherent risks.

concentration could significantly influence banks' performance (e.g. Laeven & Levine, 2009; Omran, 2009; Dong et al., 2014). Therefore, in order to control for the impact of ownership concentration on bank efficiency and risk, we include two measures. The first (*Largeshar*) is the percentage of shares held by the largest shareholder. This shareholder has superior control rights so it controls the bank's decision-making and operations. The second measure (*HH2)* is the Herfindahl index of the second- to the tenth-largest shareholders' holdings. As an aggregate, *HH2* represents a 'combined' block shareholder of ownership concentration that fulfils the very important function of counterbalancing the power of the first largest shareholder as they have incentives to monitor and restrain it directly. Therefore, the higher the concentration of shareholding in the hands of these large shareholders, the higher could be the efficiency of the banking firm, thanks to greater controls (Bai, Liu, Lu, Song, & Zhang, 2004) and potentially higher competitive pressures.

Several studies have shown that state-owned banks are often associated with lower efficiency (e.g. Fries & Taci, 2005; Bonin, Hasan, & Wachtel, 2005), and greater risk taking (e.g. Iannotta, Nocera, & Sironi, 2013). Therefore, we include the variable *Statecontrol* which is set equal to one for banks whose largest (controlling) shareholder is a government agency or state-owned enterprise (SOE), and zero otherwise. *Performpay* is the dummy variable, which is set equal to one for banks with CEO performance-related compensation scheme, and zero otherwise, and *List* is a dummy that indicates whether or not a bank's shares are publicly traded on a stock exchange. This variable is included in order to capture the fact that listing status may improve a bank's efficiency and reduce excess risk taking because of the market discipline mechanism and the requirement for better corporate governance that is imposed when listing on a stock exchange (see Ray & Das, 2010).

Concerning the bank-specific variables, *Netloansta* is net loans as a proportion of total assets, which measures the relative importance of the traditional banking business (de Andres

& Vallelado, 2008; Aebi et al., 2012). The ratio of total shareholders' equity to total assets (*Equityasset*) is used to measure banks' solvency risk (Berger & Mester, 1997; Hughes & Mester, 2012). To control for bank liquidity, we include the ratio of liquid assets to total assets (*Liquidast*) and the ratio of total loans to total deposits (*Loandepr*) (as, for example, in Wang et al., 2012). *Totassets* is the natural logarithm of the bank's total assets, which controls for size (Delis & Kouretas, 2011; Liang et al., 2013).

At the macroeconomic level, we include the real GDP growth rate to account for the general economic environment in China over the sample period (Ferri, 2009). We also include a (*Crisis*) dummy variable to capture the potential impact of the financial crisis on efficiency and risk of Chinese banks. It takes the value of 1 for the years in the post-global financial crisis period (i.e. 2008-2011), and zero for the years before global financial crisis (i.e. 2003-2007). Finally, the time trend variable (*Trend*) is included in order to control for the effects of technical progress and other factors that might affect bank efficiency and risk-taking behaviour. Detailed definitions of the variables employed in the regressions are reported in Appendix A.

As described in Section 3.2, we conjecture that board characteristics may have an incremental impact on efficiency and risk taking for those banks with high ownership concentration. To this end, we define a dummy variable, *Concen*, which is equal to 1 if a bank's Herfindahl index is greater than the median value over all banks and zero otherwise (ownership-concentrated vs ownership-dispersed). The Herfindahl ownership index that captures the level of ownership concentration for the ten largest shareholders is calculated as the sum of the squared ownership shares of the first- to tenth-largest shareholders of the bank. Specifically, it is equal to $\sum_{i=1}^{10}(own_i)^2$, where i=1,…10 and own_i is the proportion of shares owned by the i^{th} largest shareholder. We incorporate the interaction terms between *Concen* and the board characteristics explaining size, composition and functioning, into our baseline

model (equation 1). Statistically significant coefficients will indicate a difference between the impacts of the board characteristics for banks with high and low ownership concentration.

In a similar fashion, using the dummy *Statecontrol*, we include the interactions terms between state-controlled banks and the board characteristics into model (1) to test whether these latter have an incremental effect on bank efficiency and risk taking for this specific types of banks. Finally, to verify whether the impact of banks' board characteristics on efficiency and risk is different for those banks with CEO performance-related compensation schemes, we also include interactions terms between the dummy *Performpay*, with the board characteristics into equation (1).

4.2 Data sources

Detailed bank governance information was manually collected from the individual banks' annual reports. Financial data were extracted from the international database BankScope. After excluding observations with missing accounting data, our final sample comprises 633 yearly observations covering 105 Chinese commercial banks over the period from 2003 to 2011. The sample comprises five large State-owned Commercial Banks (SOCBs)[10], 12 Joint Stock Commercial Banks (JSCBs), 82 city commercial banks and seven rural commercial banks and, at the end of 2011, it represented approximately 74% of the total assets of the Chinese banking system. The descriptive statistics for the key variables of

[10] The Bank of Communications (BOCOM) used to be classed as a JSCB. However, it was much larger than the other JSCBs, and its shares were owned by a number of different state-owned entities. Therefore, in 2006, the CBRC redefined it as a SOCB thereby joining the *Big Four* (see footnote 2) to form "the Big Five".

interest are reported in Table 2. The specific definitions and data sources are provided in Appendix A.

[Insert Table 2 around here]

Panel A shows that the mean (median) profit efficiency levels, $\boldsymbol{\pi}$-eff, are 66.2% (69.3%) ranging between 17.2% and 93.8%; while the mean (median) cost efficiency, *c-eff*, is 90.4% (91.3%) which is comparable with findings from other recent studies on the efficiency of Chinese banks (Berger et al., 2009) and, as expected, is considerably higher than the profit efficiency. Our chosen measure of risk is NPLs over total loans that averages out at around 2.4% for the banks in our sample and peaks at approximately 20%. In the same table, panel B presents the summary statistics for board characteristics. It is possible to note that the average Chinese bank board comprises around 13 members, with boards with as few as four members and others with as many as 19. In addition, the average bank has around 10% female directors, 4.4% foreign directors and nearly 26% executive directors. Finally, the typical bank has seven board meetings per year, although for some institutions this can reach 43 such gatherings. The model also includes selected bank-specific and macro-economic variables. Interestingly, the average Chinese bank has a level of net loans to total assets ratio, *Netloansta*, of around 50% and the variation is very small (only 10%).

Table 3 presents Spearman rank correlation coefficients for all our variables of interest, except the dummy variables. Some of these relationships are statistically significant and positive, despite some being low, as, for instance, between profit efficiency and the proportion of female and executive directors (0.09 and 0.14, respecitvely).

[Insert Table 3 around here]

5. Empirical results

5.1 Board characteristics, efficiency and risk: baseline models

This paper's primary goal is to analyse empirically the impact of alternative board characteristics on bank-specific efficiency levels as well as risk associated with lending activity measured by NPLs/Total loans. We employ the two-step system dynamic Generalised Method of Moments (GMM) with Windmeijer-corrected standard errors to address potential endogeneity issues. We first regress bank profit and cost efficiency on board size and a set of four variables describing board composition (namely female, foreign, executive and independent directors) and a set of two variables on board functioning (CEO/chairperson duality and frequency of board meetings) separately. Then we test all board characteristics in the third model (column c). In all models, we include a squared term for board size to allow for possible non-linearities in the relationship with measures of efficiency and risk. As in the case of Berger et al. (2009) we consider profit efficiency as a better indicator of the quality of bank management compared to cost efficiency, the main reason being that profit efficiency includes both cost and revenue performance. Therefore, any qualitative differences in the results between the estimated profit- and cost-efficiency scores are attributable to differences in the banks' revenue performance.

As shown in Table 4, increases in Chinese banks' board size seem to be associated with lower profit efficiency. In addition, with the only exception of the first model (π-eff (a)), our evidence rules out significant non-linearities, thereby rejecting in most cases our hypothesis H_1 on the quadratic relation between board size, efficiency and loan quality. Concerning the composition of the board, we find some interesting relationships and partial support for our second hypothesis H_2, that the presence of more diverse and independent boards positively impacts bank efficiency and loan quality, although there are some exceptions. In particular,

our evidence suggests that the inclusion of greater gender diversity on the board not only can improve banks' profit and cost efficiency but can also lower risk, thereby giving full support to hypothesis H_2a. The coefficients on the female director (0.901 in the profit model that includes all variables) are positive and economically significant for profit efficiency. For a bank with the median level of the proportion of female directors (7.7%), a one standard deviation increase in the proportion of female directors (i.e. 9.3%) leads to an increase in profit efficiency of 8.38%. These results corroborate the abundant literature on the finding that gender diversity of the board has a positive impact on bank performance (e.g. Gul et al., 2011, Minton et al., 2011) and can reduce risk taking (Qian, Zhang, & Liu , 2015).

[Insert Table 4 around here]

In contrast, we find mixed results in relation to the impact of a greater proportion of foreign directors on the board. The negative coefficient of *Fordir* in the first profit efficiency regression provides support to the arguments (Adams, Hermalin, & Weisbach, 2010; Masulis et al., 2012) that foreign directors may not be familiar with the local systems. Consequently, they may not be able to exert effective supervision that may improve banks' profit efficiency. However, this negative impact of foreign directors becomes insignificant when all board variables are incorporated and turns positive when tested against cost efficiency. These latter results therefore suggest that we find mixed results and only partial support for our hypothesis H_2b - that foreign directors' extensive experience and knowledge of foreign markets and networking abilities can enhance bank efficiency levels and asset quality.

Furthermore, our evidence shows lack of support for our hypothesis H_2c as we find evidence of a statistically negative relationship between the proportion of executive directors and both profit and cost efficiency while the coefficient for risk is insignificant. It is possible

that the increase in insider directors on the board leads to the deterioration in the quality of the supervision of managers and an increase in conflict of interests among shareholders that in turn increases cost inefficiencies.

Finally, we observe a significantly positive relationship between the percentage of independent directors and Chinese banks' profit efficiency (hypothesis H_2d). These findings are in line with previous studies (e.g. de Andres & Vallelado, 2008, and Liang et al., 2013) and indicate that profit efficiency can be improved by strengthening internal corporate governance mechanisms through greater board independence, although these impacts are statistically insignificant for banks' cost efficiency and risk taking.

In relation to the variables explaining the functioning of the board, we find that the coefficients on *Duality* are negative and statistically significant in profit efficiency models (see, for example, Kaymak & Bektas, 2008 and Wang et al., 2012 for similar results). This means that the dual appointment of CEO and chairperson can exacerbate the agency problems and thus in turn reduce banks' profit efficiency. Although these results seem to confirm the empirical prediction of our entrenchment hypothesis H_3, the impact of duality on efficiency is not straightforward. This is because our models also yield a significant, albeit small, positive effect on cost efficiency levels, which supports the stewardship and organisational view of, for example, Anderson & Anthony (1986), that the dual appointment of CEO and chairperson of the board can help reduce information costs and improve the organisational efficiency of the board.

Finally, the estimated coefficients explaining the frequency of board meetings are relatively small, although significantly different from zero, and seem to have an opposite impact on profit and cost efficiency. Overall, they do not appear to be an economically significant factor in explaining Chinese banks' efficiency and risk taking activities. This

means that we reject our hypothesis H_4 that predicts a positive association between a high frequency of meeting and bank efficiency and risk-taking activities.

For all models in Table 4, we also incorporate a set of control variables. Previous studies have documented that an increase in the size of the largest shareholder may weaken internal corporate governance and stimulate the expropriation of minority shareholders and earnings manipulation. By contrast, our results show that the coefficients on *Largeshar* in the majority of cases are statistically insignificant for both efficiency and risk taking. In addition, we find that the nature of the controlling shareholder (i.e. state-owned vs non-state owned banks) appears to impact cost efficiency more than profit efficiency and risk.

Other findings from the estimations reported in Table 4 that are worth noting concern the bank-specific variables. The liquidity ratio (*Liquidast*), in particular, appears to impact negatively and significantly on bank efficiency, both on the profit and cost sides; and is also associated with higher risk-taking activity. Interestingly, banks that have a greater focus on traditional lending are more profit-efficient but incur higher costs as evidenced by the sign of the variable *Netloansta*. The level of capitalisation (*Equityasset*) and the ratio of loans to deposits (*Loandepr*) appear to significantly affect profit (cost) efficiency negatively (positively) but not risk; however, this latter seems to increase with size (*Totasset* is positive in all cases).

Among the macro variables, the significant and positive *Ecogrow* coefficients indicate that Chinese banks' profit efficiency is considerably higher when the economy is growing, while economic growth (and the global crisis) in China appear to have a negative impact on banks' cost efficiency.[11]

[11] The p-values of AR(2) and Hansen tests are all greater than 0.1 for the third model with all board characteristics' variables. Following Pathan and Faff (2013), we expect statistically significant AR(1) due to the way of construction and statistically insignificant AR(2). The Hansen J-statistics of over-identifying restrictions

Overall, we find evidence that board characteristics generally exert more influence on banks' profit and cost efficiency rather than risk does. As discussed above, one of the key findings of this study is the relative importance of the proportion of female directors on the board that appears to not only increase profit and cost efficiency significantly but also to reduce risk; and, at least as far as profit efficiency is concerned, the proportion of independent directors. Our results are broadly confirmed when we estimate the efficiency scores using the value-added approach.[12] They are also confirmed when we carried out the same analysis based on a subsample, which excludes the ten largest banks ranked by total assets. [13]

5.2 Additional tests

The effect of board governance features on bank efficiency and risk taking may vary between banks with different ownership characteristics and incentive structures. To test the incremental effect of different levels and types of ownership as well as CEOs' pay-performance incentives, we incorporate the interaction terms between the board

is statistically insignificant and this indicates that the instruments are valid in the two-step system GMM estimation. Overall, these imply that the model with all board characteristics' variables is well fitted with statistically insignificant test statistics for both second-order autocorrelation in second differences (AR(2)) and the Hansen J-statistics.

[12] We also used the Herfindahl index of the largest to tenth-largest shareholders' holdings into our baseline model as a robustness test, and the results are consistent. On the value-added approach, see for example, Berger and Humphrey (1997). Robustness tests results are omitted for brevity but available from the authors upon request.

[13] We thank an anonymous reviewer for pointing out that our results could be driven by the very large banking institutions in our sample. We re-run the baseline regression models based on a sub-sample that excludes them. Results are consistent with those for the full sample and are available from the authors upon request.

characteristics and three dummy variables, *Concen*, *Statecontrol* and *Performpay* (see Appendix A for more details).

Concentrated ownership has long been a defining feature of banks in emerging markets, in contrast to their counterparts in developed markets. Chinese banks provide a useful setting in which to investigate whether board characteristics have different impacts on their efficiency and risk-taking behaviour under such conditions. In particular, these differences should be more evident in China as the corporate governance and minority shareholder protection are relatively weak. To this end, we incorporate the interaction terms of board characteristics and the ownership concentration dummy, *Concen*, that equals 1 for banks whose Herfindahl index of top ten largest shareholders' holdings is greater than the median, and zero otherwise. These interaction terms are used to test the incremental effects of board characteristics when ownership concentration is high. Panel (a) of Table 5 reports the results for all models (control variables are included in the estimation but not reported). It shows that there is some evidence of non-linear relationships between board size and efficiency for banks with concentrated ownership and state ownership but that the economic significance and magnitude of coefficients are very small.

[Insert Table 5 around here]

Table 5 (panel (a)) also reveals that a greater proportion of independent and executive directors as well as CEO duality are associated with higher profit efficiency when banks' ownership concentration is high. This provides evidence that in banks characterised by high ownership concentration there are aspects of board diversity that can help mitigate the negative effects of having powerful controlling shareholders, and that may result in gains on the profit side. It is intriguing that the incremental effect of a greater number of board

meetings is positive on cost efficiency but negative on profit efficiency in more concentrated banks. This mixed evidence adds to the existing ambiguous literature on the effects of the frequency of board meetings for bank performance. Focusing on the cost side ((c-eff in panel (a)), the impact of the presence of more independent directors for banks with concentrated ownership is negative and significant when interacted (*Bindep*dummy* is -.078).

As discussed above, the ownership structure (state-owned versus non-state-owned) can also affect the performance of banks and their risk-taking propensity (see, for example, Berger et al., 2009 for a recent study on Chinese banks). In Table 5 (panel (b)) we re-estimate our baseline model with interaction terms of board characteristics' variables and the state-owned dummy (i.e. a government agency or SOE controlled organisation). Our evidence points to three key results. First, we find some evidence of positive incremental effect of specific board characteristics on profit efficiency for state-owned banks and these correspond to those also found in panel (a) i.e. executive and independent directors. Second, these latter enter significantly the interacted variable *Bindep*dummy* both in the case of efficiency (positively) and risk (negatively). Third, for all models and with only few exceptions, most coefficients for non-interacted variables are statistically insignificant. In contrast, when variables are interacted with the state-owned dummy, they become significant particularly as far as the profit efficiency is concerned; while risk is, contrary to our expectations, seldom statistically significant. The general implication of these results is that the type of controlling ownership appears to drive the significant impact of board characteristics.

Finally, we include the interaction terms of board characteristics and the CEO performance-related pay dummy, *Performpay*, to examine whether the adoption of the CEO performance-related compensation schemes affects their banks' performance and/or risk-taking activities. A performance-related CEO compensation package should provide incentives for top managers to focus on banks' performance and growth and this, in turn, can

further mitigate agency problems. However, it could also trigger short-termism and a greater risk-taking propensity thus resulting in a greater proportion of bad loans. Our findings are reported in panel (c)) of Table 5, and show that, contrary to the previous case of state-owned banks, the incremental effect of greater diversity on the board seems to be stronger for cost efficiency than profit or risk. In most cases, the effect when significant is negative, as for example for foreign, executive and independent directors. Interestingly, the presence of female directors manifests a positive and significant effect (at the 1% level) on cost efficiency, while it has a negative effect on profit efficiency when a performance-related compensation system is applied.

6. Conclusions

The Chinese banking sector has undergone major reforms over the past two decades. Despite the extraordinary growth, the country is characterised by highly concentrated corporate ownership structures, particularly in the banking sector, and weak minority shareholder protection. Using manually collected governance data, this study analyses the impact of various board characteristics on the performance of Chinese banks from 2003 to 2011. As far as we are aware, this is the first study to examine these effects on both profit and cost efficiency specifically for Chinese banks and to extend the investigation to the link with banks' risk-taking behaviour.

Our evidence suggests that board characteristics tend to have a greater influence on banks' profit and cost efficiency than risk taking. A key finding of this study is that the proportion of female directors on the board appears not only to be linked to higher profit and cost efficiency but also to lower traditional banking risk. These results are consistent with the abundant literature that shows that greater gender diversity on boards has a positive impact on

bank performance (Gul et al., 2011; Minton et al., 2011) and reduces risk taking behaviour (Qian et al., 2015). Likewise, our findings show that a higher level of board independence can also be associated with banks' higher profit efficiency, while the opposite is found for executive directors and in the presence of dual leadership of the CEO/chairperson. Among the control variables, bank liquidity appears to be the most significant variable affecting both banks' profit and cost efficiency (negatively in both cases) and increasing risk. This is an important finding as in the aftermath of the global crisis prudential regulators are increasingly focusing on banks' liquidity to complement minimum capital requirements.

When we examine the effects for banks with different ownership structures, we find that one of the key differences across the two types of ownership structure is the impact on profit efficiency. Specifically, we find that the incremental effects of board governance structures for banks characterised by concentrated ownership when significant are usually positive (as in the case of executive and independent directors), whereas results for risk are always insignificant. Our evidence also reveals that the same two specific board composition variables have a positive incremental impact on profit efficiency in the case of state owned banks. Interestingly, for banks with CEO performance-related pay the effect on efficiency when significant is usually negative.

With increased competitive pressures as a result of the changes in the financial system, there is no doubt that Chinese banks need to become more profitable and cost-effective while improving their internal controls and risk management systems. This is a problem also faced by banks operating in other emerging markets characterised by similar environmental conditions such as a high level of ownership concentration and state controls combined with underdeveloped legal systems and weak minority shareholder protection. Although in recent years a range of modern corporate governance mechanisms for banking institutions has been introduced in China, there are still a number of challenges ahead. The findings in this paper

offer useful insights to policy makers charged with the task of reforming the banking sector in emerging markets.

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Table 1 Board composition of selected Chinese commercial banks (end of 2011)

Bank	Type of bank	No. of board directors	Foreign directors	Female directors	Executive directors	Independent directors
Agricultural Bank of China	SOCB	14	2 (14%)	0 (0%)	4 (28%)	4 (28%)
China Construction Bank	SOCB	13	3 (23%)	3 (23%)	4 (31%)	4 (31%)
Shanghai Pudong Development Bank	JSCB	19	1 (5%)	1 (5%)	3 (16%)	7 (39%)
Industrial Bank	JSCB	15	2 (13%)	1 (7%)	5 (33%)	5 (33%)
China Zheshang Bank	JSCB	16	0 (0%)	4 (25%)	2 (12.5%)	4 (25%)
Bank of Ningbo	CCB	19	2 (10%)	1 (5%)	2 (10%)	6 (31%)
Bank of Guangzhou	CCB	9	0 (0%)	1 (11%)	3 (33%)	0 (0%)
Fudian Bank	CCB	13	0 (0%)	2 (15%)	4 (31%)	4 (31%)

Source: Individual banks' annual reports (2011).

Notes: SOCB=State--owned Commercial Bank; JSCB=Joint Stock Commercial Bank; CCB=City Commercial Bank. The proportion of each type of director on the board is reported in brackets.

Table 2 Summary statistics (pooled data 2003-2011)

Variable	Mean	S.D.	Min	0.25	Mdn.	0.75	Max
Panel A Bank efficiency and risk variables							
π-eff	0.662	0.165	0.172	0.551	0.693	0.796	0.938
c-eff	0.904	0.039	0.709	0.886	0.913	0.93	0.976
NPLs / Total Loans[a]	0.024	0.027	0.000	0.008	0.014	0.028	0.200
Panel B Board size, composition and functioning							
Bsize	12.780	3.223	4.000	11.000	13.000	15.000	19.000
Femdir	0.099	0.093	0.000	0.000	0.077	0.167	0.429
Fordir	0.044	0.084	0.000	0.000	0.000	0.067	0.462
Execdir	0.258	0.113	0.000	0.176	0.267	0.308	0.800
Bindep	0.191	0.127	0.000	0.083	0.200	0.313	0.444
Bmeeting	7.104	4.492	1.000	4.000	6.000	8.000	43.000
Panel C Control variables							
Largeshar	0.230	0.181	0.040	0.110	0.190	0.260	1.000
HH2	0.036	0.029	0.000	0.017	0.028	0.047	0.25
Netloansta	0.501	0.100	0.038	0.447	0.510	0.572	0.743
Equityasset	0.060	0.022	0.004	0.046	0.058	0.069	0.16
Liquidast	0.257	0.107	0.035	0.179	0.24	0.32	0.668
Loandepr	0.646	0.116	0.206	0.580	0.660	0.719	1.098
Totassets	10.842	1.766	7.665	9.638	10.374	11.751	16.101
Ecogrow	0.107	0.017	0.092	0.093	0.101	0.113	0.142
Panel D Dummy variables							
	Duality	*Concen*	*Performpay*	*Statecontrol*	*List*		
Frequency counts	64	310	441	337	95		
Mean	0.101	0.490	0.697	0.532	0.150		

Note: All variables are as defined in Appendix A. *π-eff* and c-eff are estimated using stochastic frontier methodology as explained in Appendix B. The total number of bank observations is 633.

[a] Since we include in our sample newly established banks (e.g. Zheshang Commercial Bank) that did not report any NPLs in the first 1-2 years, the minimum of this ratio is zero.

Table 3 Correlation matrix

	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*	*(13)*	*(14)*	*(15)*	*(16)*	*(17)*
(1) π-eff	1																
(2) c-eff	-0.18*	1															
(3) NPLs	0.01	0.01	1														
(4) Bsize	0.05	0.01	0.16*	1													
(5) Femdir	0.09*	-0.05	0.06	0.19*	1												
(6) Fordir	0.02	0.06	0.25*	0.45*	0.05	1											
(7) Execdir	0.14*	-0.05	0.05	-0.29*	-0.01	-0.18*	1										
(8) Bindep	0.04	0.06	0.21*	0.67*	0.17*	0.52*	-0.30*	1									
(9) Bmeeting	0.07*	-0.13*	0.16*	0.33*	0.16*	0.23*	-0.19*	0.43*	1								
(10) Largeshar	-0.04	-0.04	0.07*	-0.18*	0.06	0.27*	0.08*	-0.01	0.09*	1							
(11) Netloansta	-0.02	0.25*	-0.17*	-0.00	-0.11*	-0.07*	-0.02	-0.05	-0.06	-0.15*	1						
(12) Loandepr	-0.15*	0.36*	-0.08*	0.15*	-0.04	0.10*	-0.15*	0.16*	0.03	-0.10*	0.78*	1					
(13) Toasset	0.07*	-0.01	0.25*	0.60*	0.18*	0.62*	-0.19*	0.67*	0.42*	0.15*	-0.12*	0.10*	1				
(14) Equityasset	0.04	0.10*	0.10*	-0.02	0.05	-0.14*	0.11*	0.01	-0.00	-0.15*	-0.00	-0.04	-0.20*	1			
(15) Liquidast	0.05	-0.00	0.14*	-0.11*	-0.09*	0.09*	0.10*	0.03	0.00	-0.02	-0.40*	-0.34*	-0.12*	0.17*	1		
(16) HH2	-0.12*	-0.08*	-0.11*	-0.14*	0.01*	0.02	0.04	-0.11*	0.07*	0.10*	-0.15*	-0.16*	-0.18*	0.06	0.13*	1	
(17) Ecogrow	0.08*	0.01	-0.30*	-0.03	-0.05	-0.00	-0.05	-0.14*	-0.12*	-0.01	0.15*	0.09*	-0.11*	-0.26*	-0.26*	-0.04	1

Note: This table reports the Spearman rank correlation between variables. All variables are as defined in Appendix A. The sample period is between 2003 and 2011. * p<0.10.

Table 4 Board characteristics, bank efficiency and risk in Chinese banks (2003-2011)

Dependent Var (DEP)	Profit Efficiency			Cost Efficiency			Non-Performing Loans /Total Loans		
	π-eff (a)	π-eff (b)	π-eff (c)	c-eff (a)	c-eff (b)	c-eff (c)	NPLs (a)	NPLs (b)	NPLs (c)
Lag DEP	-0.114***	-0.083***	-0.117***	-0.005	0.026	-0.005	0.905***	1.047***	0.914***
	(-4.210)	(-3.894)	(-4.159)	(-0.117)	(0.851)	(-0.100)	(3.782)	(6.979)	(3.239)
Bsize	-0.052**		-0.021	0.012		0.009	0.006		0.017
	(-2.087)		(-0.771)	(1.575)		(1.122)	(0.198)		(0.516)
Sqbsize	0.003***		0.001	-0.000*		-0.000	-0.000		-0.001
	(2.718)		(1.097)	(-1.670)		(-1.229)	(-0.338)		(-0.596)
Femdir	0.914***		0.901***	0.104***		0.156***	-0.561***		-0.694***
	(3.842)		(3.973)	(3.100)		(4.143)	(-3.252)		(-2.636)
Fordir	-0.447**		-0.195	0.174***		0.138**	-0.068		-0.094
	(-2.481)		(-0.857)	(3.354)		(2.317)	(-0.489)		(-0.620)
Execdir	-0.536***		-0.351**	-0.110***		-0.096***	-0.008		0.045
	(-4.809)		(-2.559)	(-5.977)		(-4.508)	(-0.124)		(0.420)
Bindep	0.239**		0.323***	-0.019		0.012	-0.077		-0.056
	(2.406)		(3.079)	(-1.289)		(0.751)	(-1.085)		(-0.702)
Duality		-0.249***	-0.154***		0.026***	0.024**		0.017	-0.005
		(-8.268)	(-4.010)		(4.371)	(2.468)		(1.545)	(-0.158)
Bmeeting		0.008***	0.002		-0.002***	-0.001**		0.002	-0.003
		(5.467)	(1.185)		(-4.707)	(-2.113)		(0.942)	(-0.780)
Largeshar	-0.103	-0.221***	-0.160	0.032*	-0.011	0.019	0.133	0.027	0.157
	(-1.057)	(-2.789)	(-1.500)	(1.684)	(-0.580)	(1.040)	(1.291)	(0.425)	(1.297)
HH2	1.123**	0.425	0.704	0.325**	0.276***	0.159	0.652	-0.186	0.905
	(2.239)	(1.289)	(1.619)	(2.226)	(2.647)	(1.059)	(1.042)	(-0.553)	(1.245)
Performpay	-0.062**	-0.113***	-0.059*	0.006	0.001	-0.008	-0.003	-0.005	-0.017
	(-2.148)	(-3.955)	(-1.890)	(0.803)	(0.140)	(-0.985)	(-0.128)	(-0.351)	(-0.547)
Statecontrol	0.012	0.004	0.016	0.029***	0.031***	0.034***	-0.034	-0.012	-0.040
	(0.540)	(0.125)	(0.675)	(3.947)	(6.309)	(4.335)	(-1.552)	(-0.991)	(-1.618)
List	-0.043	0.075**	0.007	0.003	0.024**	0.011	-0.044	-0.060	-0.017
	(-0.588)	(2.109)	(0.098)	(0.148)	(2.348)	(0.531)	(-0.687)	(-1.294)	(-0.193)
Netloansta	0.208	0.781***	0.424**	-0.196***	-0.148***	-0.181***	0.361	0.150	0.519
	(1.003)	(4.925)	(2.360)	(-4.568)	(-4.436)	(-4.122)	(1.259)	(0.846)	(1.253)
NPLs	-0.526***	-0.046	-0.307*	-0.112***	0.147***	-0.032			
	(-2.832)	(-0.282)	(-1.665)	(-2.964)	(5.681)	(-0.597)			
Equityasset	-3.112***	-3.400***	-3.286***	0.705***	0.910***	0.782***	0.251	0.308	0.436
	(-6.961)	(-5.959)	(-6.501)	(6.411)	(8.248)	(6.540)	(0.424)	(0.749)	(0.566)
Liquidast	-0.520***	-0.350***	-0.475***	-0.048	-0.130***	-0.072**	0.309**	0.238***	0.339**
	(-3.638)	(-3.018)	(-2.968)	(-1.593)	(-7.597)	(-2.147)	(2.481)	(2.804)	(2.230)
Loandepr	-1.151***	-1.218***	-1.126***	0.383***	0.233***	0.320***	-0.030	0.027	-0.194
	(-9.578)	(-7.982)	(-8.082)	(9.741)	(7.412)	(7.283)	(-0.160)	(0.268)	(-0.678)
Totasset	-0.020	0.001	-0.035*	-0.004	-0.002	-0.005	0.035**	0.021*	0.040*
	(-1.220)	(0.096)	(-1.925)	(-0.886)	(-0.694)	(-1.345)	(2.137)	(1.645)	(1.838)
Ecogrow	1.868***	1.880***	1.450**	-0.545***	-0.208***	-0.358***	0.232	0.023	0.303
	(3.382)	(5.709)	(2.495)	(-5.358)	(-2.776)	(-2.965)	(0.692)	(0.104)	(0.766)
Crisis	0.027	0.036**	0.005	-0.035***	-0.023***	-0.027***	0.012	0.004	0.014
	(1.036)	(2.331)	(0.195)	(-6.546)	(-4.774)	(-4.605)	(0.598)	(0.294)	(0.586)
Trend	0.023***	0.031***	0.024***	0.004**	0.003**	0.003**	-0.001	-0.005	-0.002
	(4.656)	(7.851)	(4.263)	(2.568)	(2.436)	(2.170)	(-0.266)	(-1.376)	(-0.329)
Constant	1.819***	1.057***	1.707***	0.740***	0.798***	0.779***	-0.624**	-0.371**	-0.751**
	(7.480)	(5.189)	(5.518)	(10.729)	(23.035)	(10.298)	(-2.153)	(-2.146)	(-1.994)
Obs	527	527	527	527	527	527	527	527	527
AR(1)	0.053	0.013	0.041	0.022	0.021	0.024	0.026	0.018	0.045
AR(2)	0.075	0.174	0.108	0.731	0.499	0.475	0.758	0.796	0.991
Hansen	0.819	0.821	0.786	0.704	0.472	0.612	0.875	0.792	0.917

Note: All variables are as defined in Appendix A. The regressions are estimated by the two-step system GMM estimator with Windmeijer's (2005) corrected standard errors (reported in brackets). The *p* values of AR(1), AR(2) and the Hansen test statistics of over-identifying restrictions are also reported; *,**,*** indicates significance at the 10%, 5% and 1% levels.

Table 5 Board characteristics, bank efficiency and risk in Chinese banks by ownership and performance-related CEO compensation (2003-2011)

	Panel (a)			Panel (b)			Panel (c)		
Dependent variables (DEP)	π-eff	c-eff	NPLs	π-eff	c-eff	NPLs	π-eff	c-eff	NPLs
Lag of DEP	-0.087**	-0.044	0.162	-0.024	-0.081	0.295*	-0.058	-0.166***	0.419*
	(-2.165)	(-0.740)	(0.657)	(-0.629)	(-1.583)	(1.715)	(-1.351)	(-3.065)	(1.668)
Bsize	0.110***	0.021*	0.032	-0.146***	0.044***	0.119	-0.028	-0.005	0.117*
	(2.723)	(1.931)	(0.788)	(-2.979)	(2.908)	(1.484)	(-0.283)	(-0.270)	(1.953)
Sqbsize	-0.003*	-0.001**	-0.002	0.006***	-0.001***	-0.005	0.001	0.000	-0.005*
	(-1.908)	(-2.005)	(-1.057)	(3.039)	(-2.586)	(-1.642)	(0.351)	(0.485)	(-1.749)
Femdir	0.885*	0.154*	-0.005	1.303***	0.060	-1.043	3.950***	-0.605***	-0.076
	(1.706)	(1.884)	(-0.010)	(3.938)	(0.636)	(-1.621)	(5.455)	(-2.756)	(-0.093)
Fordir	0.148	0.164	0.287	-0.238	0.028	-0.451	0.383	0.239	1.907*
	(0.300)	(1.636)	(0.928)	(-0.603)	(0.324)	(-1.074)	(0.354)	(1.284)	(1.740)
Execdir	-1.159***	-0.180***	0.043	-0.405	-0.034	0.386	-0.242	0.059	0.299
	(-4.675)	(-2.809)	(0.208)	(-1.251)	(-0.641)	(1.333)	(-0.636)	(0.633)	(1.135)
Bindep	-0.462**	0.081***	-0.117	0.277**	0.025	-0.072	0.088	0.180***	-0.184
	(-2.408)	(2.760)	(-0.740)	(2.095)	(0.813)	(-0.552)	(0.525)	(4.396)	(-1.231)
Duality	-0.322***	0.003	-0.036	0.096	0.011	-0.049	-0.201	0.142	0.136
	(-3.866)	(0.156)	(-0.634)	(1.363)	(0.529)	(-0.785)	(-0.325)	(1.274)	(0.347)
Bmeeting	0.015***	-0.004**	0.009	0.006	-0.005***	0.002	0.013***	-0.006***	0.005
	(2.688)	(-2.424)	(1.561)	(0.911)	(-3.473)	(0.570)	(2.739)	(-3.171)	(0.929)
*Bsize*dummy*	-0.025	-0.010**	0.000	0.266***	-0.045**	-0.089	-0.077	0.037**	-0.113
	(-1.280)	(-2.343)	(0.029)	(4.275)	(-2.197)	(-1.319)	(-0.763)	(2.246)	(-1.572)
*Sqbsize*dummy*	-0.001	0.001**	-0.000	-0.010***	0.001	0.004*	0.002	-0.001**	0.004
	(-0.609)	(2.390)	(-0.113)	(-4.087)	(1.251)	(1.784)	(0.556)	(-2.169)	(1.391)
*Femdir*dummy*	0.360	-0.041	0.181	-1.009*	0.025	0.770	-3.076***	0.673***	0.479
	(0.679)	(-0.399)	(0.330)	(-1.857)	(0.192)	(1.221)	(-4.410)	(3.142)	(0.616)
*Fordir*dummy*	-0.616	-0.117	-0.378	-0.389	0.038	0.562	0.641	-0.342**	-1.735*
	(-1.272)	(-1.186)	(-0.969)	(-0.686)	(0.239)	(1.266)	(0.676)	(-2.070)	(-1.805)
*Execdir*dummy*	1.483***	0.100	-0.369	0.813*	-0.085	-0.586	0.407	-0.298***	-0.770**
	(3.810)	(1.062)	(-0.879)	(1.694)	(-1.055)	(-1.500)	(1.000)	(-2.806)	(-2.447)
*Bindep*dummy*	1.175***	-0.078**	0.192	0.744**	0.127**	-0.406**	0.075	-0.276***	0.166
	(5.696)	(-2.066)	(0.924)	(2.498)	(2.237)	(-2.205)	(0.417)	(-4.347)	(0.753)
*Duality*dummy*	0.407***	0.023	0.114	-0.500***	0.012	0.179	0.142	-0.151	-0.101
	(3.098)	(0.673)	(1.162)	(-2.936)	(0.422)	(0.998)	(0.227)	(-1.332)	(-0.241)
*Bmeeting*dummy*	-0.012**	0.007***	-0.001	0.006	0.005***	-0.002	-0.025***	0.007***	0.002
	(-2.097)	(3.221)	(-0.235)	(0.797)	(2.843)	(-0.456)	(-4.019)	(3.562)	(0.281)
Constant	1.049***	0.801***	-1.344*	2.495***	0.669***	-1.769**	1.545**	0.899***	-1.315*
	(2.836)	(6.710)	(-1.724)	(7.107)	(5.458)	(-2.236)	(2.523)	(5.377)	(-1.783)
Obs	527	527	527	527	527	527	527	527	527
AR(1)	0.010	0.014	0.199	0.014	0.091	0.133	0.051	0.138	0.052
AR(2)	0.149	0.216	0.652	0.545	0.342	0.388	0.710	0.538	0.391
Hansen	0.950	0.934	0.673	0.972	0.975	0.942	0.799	0.916	0.533
Dummies for the interaction terms	*Concen* (1= *concentration > median*)			*Statecontrol* (1=*state-owned*)			*Performpay* (1=*pay-performance scheme*)		

Note: All variables are as defined in Appendix A. Control variables are included (coefficients are not reported). The models are estimated by the two-step system GMM estimator with Windmeijer's (2005) corrected standard errors (reported in brackets). The *p* values of AR(1), AR(2) and the Hansen test statistics of over-identifying restrictions are also reported; *,**,*** indicates significance at the 10%, 5% and 1% levels.

Appendix A: Variable definitions

Variable	Description	Sources
Dependent variables		
π-*eff*	Estimated alternative profit efficiency	Equation (B1)
c-eff	Estimated cost efficiency	Equation (B1)
NPLs	Non-performing loans to total loans	Annual Reports BankScope
Board governance variables		
Bsize	The total number of directors on the board	Annual Reports
Femdir	The proportion of female directors on the board	Annual Reports
Fordir	The proportion of foreign directors on the board	Annual Reports
Execdir	The proportion of executive directors on the board	Annual Reports
Bindep	The proportion of independent directors on the board	Annual Reports
Duality	A dummy variable that equals 1 if the CEO is also the Chairman or Vice Chairman of the Board, and 0 otherwise	Annual Reports
Bmeeting	The number of board meetings per year	Annual Reports
Other control variables		
Largeshar	The percentage of shares owned by the largest shareholder	Annual Reports
HH2	Herfindahl index of the second- to tenth-largest shareholders' holdings	Annual Reports Bankscope
Performpay	CEO performance-related pay dummy which is set equal to one for banks with CEO performance-related compensation schemes, and 0 otherwise.	Annual Reports Bankscope
Concen	A dummy variable that equals 1 for banks whose Herfindahl index of top ten largest shareholders' holdings greater than the median, and 0 otherwise.	Annual Reports Bankscope
Statecontrol	A dummy variable that equals 1 for banks whose largest (controlling) shareholder is a government agency or state-owned enterprise (SOE), and 0 otherwise.	Annual Reports
List	A dummy variable that equals 1 for banks that are listed in the exchanges, and 0 otherwise.	Annual Reports
Netloansta	Ratio of net loans to total assets	Annual Reports Bankscope
Equityasset	Ratio of total equity to total asset, measuring the bank's capital adequacy	Annual Reports Bankscope
Liquidast	Ratio of total liquidity assets to total assets, measuring bank liquidity	Annual Reports Bankscope
Loandepr	Ratio of total loans to total funding, measuring the bank's liquidity risk exposure	Annual Reports Bankscope
Totassets	The natural logarithm of the bank's total assets, which controls for bank size	Annual Reports Bankscope
Ecogrow	Annual growth rate of GDP.	World Bank Financial Indicators
Crisis	A dummy variable that equals 1 for the years post-global financial crisis (2008-2011), and 0 otherwise.	n/a
Trend	Time trend, which is set to 1 for the first year under study (2003), 2 for the second year (2004), and so on, up to 9 for the last year (2011).	n/a

Appendix B Measurement of profit and cost efficiency

We estimate the efficiency levels of Chinese banks using stochastic frontier analysis (SFA). We adopt the transcendental logarithmic (translog) form, which is the most commonly used functional form in the bank efficiency literature, to specify the frontier. Our empirical cost frontier model is as follows:

$$\begin{aligned}\ln(TC_{it} \text{ or } APE_{it}) = {} & \alpha + \sum_m \beta_m y_{imt} + \sum_j \gamma_j w_{ijt} + \frac{1}{2}\sum_m\sum_n \beta_{mn} y_{im} y_{in} + \frac{1}{2}\sum_j\sum_k \beta_{jk} y_{ijt} y_{ikt} + \sum_m\sum_j \psi_{mt} \ln y_{imt} \ln w_{ijt} + \varphi_1 \ln E_{it} + \frac{1}{2}\varphi_2 \ln E_{it}^2 \\ & + \sum_m \lambda_m \ln y_{imt} \ln E_{it} + \sum_j \xi_j \ln w_{ijt} \ln E_{it} + \theta_1 T + \theta_2 T^2 + \sum_m \kappa_m \ln y_{imt} T + \sum_j \rho_j \ln w_{ijt} T + \eta \ln E_{it} T + \ln NPL/TL + v_{it} + u_{it}\end{aligned} \quad \text{(B1)}$$

where the dependent variable is alternatively either TC_{it} - the observed total costs, or *APE* - the profit before tax, of bank *i* at time *t*; y_i and w_i are vectors of output and input prices for the *i*th bank; E_i is the total equity of a bank, which is treated as a quasi-fixed input; *T* is the time trend used to capture technological changes; and *ln NPL/TL* is the natural logarithm of the ratio of non-performing loans to total loans.[1] In addition, v_{it} is a two-sided normal disturbance term with zero mean and variance σ_v^2 and represents the effects of statistical noise; the inefficiency term u_{it} is assumed to be half-normally distributed; α, β, γ, ψ, φ, λ, ξ, θ, κ, ρ, and η are the parameters to be estimated, and the standard symmetry restrictions, $\beta_{nm} = \beta_{mn}$ and $\gamma_{jk} = \gamma_{kj}$, are applied. Finally, the total cost and input price terms are normalised by the last input price, in order to impose linear homogeneity of degree one on the input prices. The cost efficiency of a bank is defined as $CE_{it} = 1 / \exp(u)$ and takes a value between 0 and 1. Alternative profit efficiency (*APE*), proposed by Berger and Mester (1997), is estimated similarly to cost efficiency. We use profit before tax to replace the total cost variable as the

[1] We treat equity capital without any associated price as quasi-fixed in our frontier model because the level of equity is much more difficult to alter in the short run. It is used to control for insolvency risk and the different risk preferences of banks. We also control for asset quality by including ln NPL/TL directly into the profit and cost frontiers. See Berger and Mester (1997), Mester (1996, 1997), Altunbas, Evans, and Molyneux (2001) and Hughes and Mester (2012) for more details.

dependent variable, and the same independent variables as we used in the cost function (equation B1). The profit efficiency is given as $APE_{it} = exp\ (-u)$ and also takes a value between 0 and 1.

This study follows the intermediation approach, suggested by Sealey and Lindley (1977), to define the input and output variables. The approach treats a bank as an intermediary, which collects funds from savers and transforms those funds into profitable projects (loans and other earning assets). Accordingly, the inputs consist of the price of total borrowed funds (X_1), total physical capital (X_2), and labour (X_3). The outputs consist of total loans (Q_1), other earning assets (Q_2), and non-interest income (Q_3)[2]. Note that the input variables are not explicitly incorporated into the cost (or profit) frontier model summarised in equation (B1) but are represented by the impact of their input prices (that is, personnel expenses to the number of employees, W_1; other operating expenses to the book value of fixed assets, W_2; and interest expenses to total borrowed funds, W_3).

[2] Due to off-balance sheet items not being available for all Chinese banks, we follow previous studies and use non-interest income to capture non-traditional banking business as proxy for OBS fee service (e.g. Rogers, 1998; Lieu, Yeh, & Chiu, 2005; Lozano-Vivas & Pasiouras, 2010).